

A multicentre study on epidemiology and prevention of needle stick injuries among students of nursing schools

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Parole chiave: Rischio biologico, infortunio, punture da ago, formazione, tirocinio

Abstract

Introduction. Among the health professions with a long period of training, the students of the Nursing Bachelor's Degree are the most exposed to biological risk resulting from accidents, in particular with needles and cutting edges. The aim of the study was to estimate the frequency and the circumstances for the occurrence of needle stick injuries, as a knowledge base for targeted prevention interventions.

Methods. The study was carried out between May and July 2017 in 11 Universities in Italy and 1 in Albania (associated with the "Tor Vergata" University of Rome). An anonymous semi-structured questionnaire was proposed to 1st (second semester), 2nd and 3rd year students of Nursing Bachelor's Degree.

Results. A total of 2742 questionnaires were collected. The average age of participants was 22.9 years (median 22, range 19-60 years), 73% of whom were females. A total of 381 injuries were reported. Three hundred and sixteen students (11.8%) underwent at least 1 injury (12.7% among females, 9.7% among males); 41 students declared two or more injuries; four students did not report the number of injuries occurred. The first injury occurred, as an average, 17 days after the start of the internship (median 15 days) and, in 25% of the cases, during the first 9 days. The highest percentage of accidents occurred during the first internship (25.3% of the total) and decreased with the progress of the training path. The injuries occurred in 38% of cases during drug preparation, 24% when disposing of sharp devices, 15% while re-

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capping needles, 13% during blood sampling and 10% in other circumstances. In 51.2% of cases, the needle was not sterile. Among the nursing students who suffered a needle stick injury, 58.1% declared that they had performed the post-exposure prophylaxis. 96% of students stated to be vaccinated against Hepatitis B virus. Amongst the students who had their serological status checked (74%), 18% stated the antibody titre was not protective. 49.8% of students answered to have been trained in advance on the correct procedures to avoid needle stick and cutting edges injuries in each clinical ward attended, 41.2% referred that this occurred only in some wards and 10% in no ward at all.

Conclusions. The results of this study show a high percentage of needle stick injuries in students of the Nursing Bachelor's Degree. Therefore, there is a need for careful reflection on the most effective methods of targeted training acquisition of knowledge, skills and behavioural models useful for the exercise of the profession.

Introduction

The major occupational hazard in the clinical setting is of biological origin (40-50% of the total) (1-4). Occupational exposure, mucocutaneous and percutaneous, to blood or other biological material is a frequent and potentially serious event affecting millions of healthcare workers (HCWs). Percutaneous exposure is the predominant one: it occurs in 82% of cases, followed by mucocutaneous in 25%, and by contact with non-intact skin in 3% (3). World Health Organization (WHO) estimates that, among the 35 million HCWs worldwide, approximately 3 million experience percutaneous exposure to blood-borne pathogens annually; 2 million to hepatitis B virus (HBV), around 900,000 to hepatitis C virus (HCV) and 170,000 to human immunodeficiency virus (HIV) (1, 4). It is estimated that needle stick injuries (NSIs) cause about 66,000 HBV, 16,000 HCV and 200–5,000 HIV infections among HCWs (5). Percutaneous occupational exposure fractions attributable to HBV, HCV and HIV are 37%, 39% and 4.4%, respectively (1). These bloodborne infections have serious consequences, including long-term illness, disability and death. Today, it is clear that occupational exposure to biological risk, especially from blood-borne pathogens, is a relevant priority issue for public and private health organizations all over the

world (5-9). Among all the HCWs, nurses are the most exposed category to the risk of NSIs (2, 10-11). National data confirm the international epidemiological panorama. The report published by the Italian Study on Occupational Risk from HIV and other blood-borne pathogens (SIROH) between 1994-2013 showed the frequency of percutaneous exposures by professional profile; with 54.8% (41,094) of the nursing staff represents the category mainly involved (2). Considerable was the share of 7,981 cases (10.4%) of occupational exposure related to staff in training, of whom 3,687 (46.2%) cases involved nursing students (2). The most alarming concern refers to the high tendency of under-reporting NSIs among nursing students (7, 12-15). Hambridge (15) found that prevalence of NSIs in nursing students internationally ranges from 9.4% to 61.9% in Asia, US, Canada, Australia and European countries and non-reported injuries ranged from 39.5% to 96.24%. There is a lack of epidemiological data relating to NSIs among nursing students. The literature on the subject also presents evident differences regarding the survey methodology, making it difficult to compare the results produced in the different countries. Considering this, the Italian Study Group of Hospital Hygiene (Gruppo Italiano Studio Igiene Ospedaliera, GISIO) of the Italian Society of Hygiene, Preventive Medicine and Public Health

(SItI), promoted a multicentre study with the involvement of several nursing schools to answer the following specific questions:

- the prevalence of NSIs;
- when and where the NSIs occurred;
- the behavior adopted by nursing students following the accident;
- the vaccination status of students against hepatitis B;
- knowledge about risk factors, prevention and management of the post occupational exposure.

Methods

The study was carried out between May and July 2017 in four Universities from Northern Italy, two from Central Italy, five from Southern Italy and one from Albania (associated with the University of Rome, “Tor Vergata”). An anonymous semi-structured questionnaire was self-administered to students of the 1st (second semester), 2nd and 3rd year of Nursing Bachelor’s Degree. The questionnaire was reviewed by the members of the GISIO-SItI and consisted of 26 questions exploring 4 areas: 1) information regarding the occurred injuries: number of times, weeks of internship preceding the injury, circumstances and management of post-exposure procedure; 2) number and duration of internships and specific training received; 3) knowledge and behavior regarding biological risk: use of standard precautions, post-occupational-exposure procedure, knowledge and usage of medical devices with safety mechanism (D.M. 07.10.2011 “Classificazione Nazionale Dispositivi Medici”) 4) HBV vaccination status.

The survey was handed out without previous notice, on a randomly chosen day, to all the students attending class who previously gave voluntary consent to participate in the study. Data were collected using a specific database and analyzed using *Statistical*

Package for Social Science (SPSS) software, version 24.

Descriptive statistics were used to explore central tendency measures, dispersion measures, percentages and frequencies. Possible associations between injury and other factors (gender, bachelor year, weeks of internship preceding injury, training received) were evaluated with Chi square test and Odds ratio (OR) and 95% confidence interval (CI95%). P-value smaller than 0.05 was considered statistically significant.

Results

A total of 2,742 questionnaires were collected in 12 Universities with a median of 152 questionnaires (range: 25-556). The different locations (branches) per university were from 1 to 9. Mean age of participants was 22.9 years (median 22, range 19-60 years old), 73% of whom were female, with an average female:male ratio of 2.7. Table 1 shows the characteristics of the sample according to the different Universities.

Data about the internships are shown in Table 2. 48.5% of students were attending the 3rd year, 45.7% the 2nd year and 2.6% the 1st year of the Nursing Bachelor’s Degree; 3.2% of students did not answer the question. 82.6% had already undertaken the exam of Hygiene. The median training period was 24 weeks at the time of the survey. The median number of internships attended was 6 (from 0 to 26). A total of 381 injuries were reported (Figure 1). Three hundred and sixteen students (11.8%) underwent at least 1 injury, ranging from 7.0% to 25.6% (12.7% among females, 9.7% among males, $p < 0.05$, OR 1.39, CI 95%: 1.08-1.84); 41 students declared two or more injuries, 4 students did not report the number of injuries occurred. The highest percentage of injuries occurred during the first internship (25.3% of total injuries) and decreased along the training experience.

Table 1 - Characteristics of the sample by Universities

University	University			Mean	SD	Age			Ratio (F:M)
	No. of subjects	%	No. Branches			Median	Min	Max	
A	556	20.3	9	23.0	3.7	22.0	20	60	4
B	457	16.7	5	22.6	3.6	22.0	19	48	4.3
C	424	15.5	5	22.6	3.9	21.0	19	50	2.4
D	362	13.2	1	23.1	3.3	22.0	19	41	1.7
E	282	10.3	3	22.9	3.8	22.0	20	52	3.2
F	199	7.3	2	22.3	2.6	21.0	19	35	2
G	104	3.8	1	24.9	5.8	23.0	20	51	1.8
H	100	3.6	1	22.1	3.0	21.0	20	37	2.7
I	96	3.5	2	21.8	2.5	21.0	19	31	4
L	94	3.4	2	23.3	3.7	22.0	20	39	1.5
M	43	1.6	1	23.8	4.6	22.0	21	45	1.8
N	25	0.9	1	23.6	3.7	22.0	21	33	2.1
Total	2742	100.0	33	22.9	3.7	22.0	19	60	2.7

Table 3 shows the incidence rate in the different Universities. The first injury occurred an average of 17 days (median 15 days) after starting internship and in 25% of the cases, injury occurred in the first 9 days.

The injuries occurred in 38% of the cases during drug preparation, 24% while

disposing of sharp devices, 15% while re-capping needles, 13% during blood sampling and 10% in other circumstances. In 51.2% of cases, the needle was not sterile.

Among the nursing students who suffered a NSI, 58.1% declared they had performed

Table 2 - Weeks and number of internships by Universities

University	Weeks of internship		Number of internship		
	No. of subjects	Median of weeks	Median number of internship	Min	Max
A	506	28	9	2	20
B	412	21	5	2	15
C	346	48	7	2	17
D	280	36	4	2	26
E	225	24	7	2	13
F	192	24	5	2	15
G	104	52	2	1	6
H	95	24	6	1	19
I	91	20	3	0	8
L	82	24	5	1	12
M	41	52	6	5	10
N	25	16	3	1	6
All	2399	24	6	0	26

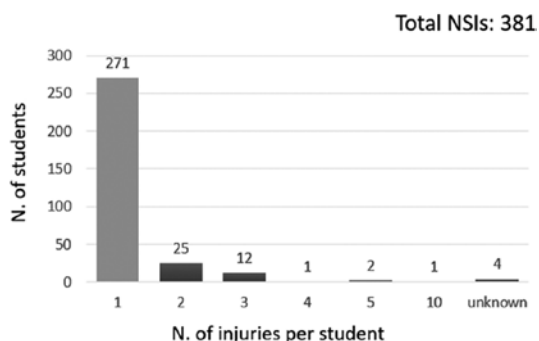


Figure 1 - Number of needle sticks injuries (NSIs).

Table 3 - Needle sticks injuries per 100 weeks and percentage of NSIs occurred during the first internship

University	No. of subjects	Accident* week* 100	Percentage of injuries occurred during first internship
A	506	0.52	18.8
B	412	0.49	22
C	346	0.30	23.3
D	280	0.45	28.1
E	225	0.70	7.4
F	192	0.34	38.5
G	104	0.17	44.4
H	95	2.55	40
I	91	0.74	83.3
L	82	1.24	33.3
M	41	0.46	0
N	25	0.41	0
Total	2399	0.52	25.3

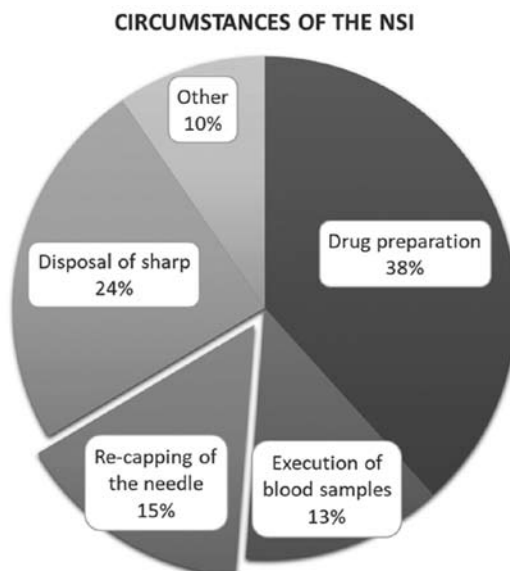
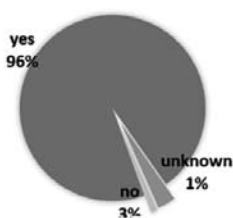


Figure 2 - Circumstances of the needle sticks injuries (NSIs).

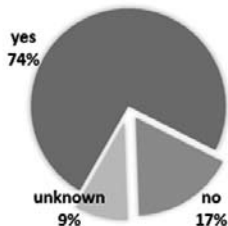
the PPE, this percentage increased if the injury occurred with a non-sterile needle (82.9%). 96% of students declared to be vaccinated against HBV. Among the students who had their titre checked (74%), 18% stated that they did not have protective titres and 18% that they did not remember the results (Figure 4).

A total of 49.8% of students declared to have been informed on the correct

VACCINE AGAINST HEPATITIS B



THE ANTIBODY TITRE WAS TESTED



THE ANTIBODY TITRE WAS PROTECTIVE

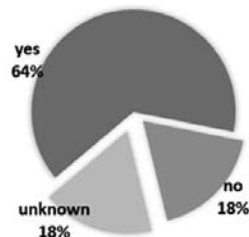


Figure 3. Vaccination anti-Hepatitis B and serological status.

Table 4. Training on safe devices

Safe devices	Yes		No		% of non-respondents	% of respondents
	No.	%	No.	%		
Butterfly needle	1,980	87.7	278	12.3	17.7	82.3
Lancet	1,872	83.5	370	16.5	18.2	81.8
Peripheral intravenous catheter	1,767	79.0	470	21.0	18.4	81.6
Disposable syringe	1,527	68.9	688	31.1	19.2	80.8
Needles, closed system collecting	1,429	64.3	794	35.7	18.9	81.1
Haemogasanalysis syringe with needle	1,257	56.6	965	43.4	19.0	81.0
Hypodermic needles for pen	1,182	53.4	1,031	46.6	19.3	80.7
Hypodermic needle for syringe	961	45.2	1,163	54.8	22.5	77.5
Needles and kit for implantable systems	585	26.7	1,605	73.3	20.1	79.9

procedures to avoid needle stick and cutting edges injuries in every clinical ward they attended, 41.2% referred that this occurred only in some wards and 10% in no ward at all. Among the 12 Universities, a statistically significant difference was observed both in the number of reported injuries and in the incidence of accidents per week of training, as well as in the circumstances of occurrence.

Overall, most of the students received specific lessons on knowledge and usage of medical devices with safety mechanism (D.M. 07.10.2011 “Classificazione Nazionale Dispositivi Medici”), even if this occurred with different percentages depending on the different devices. The specific training was frequently offered for butterfly needles (87.7%), but much less frequently (<50%) for hypodermic needles and needles and kit for implantable systems.

A significant statistical difference ($p = 0.002$) between the prevalence of injuries among students who received full training in each attended clinical ward (9.6%) and students who received training only in some wards or were not trained at all (13.6%) was observed (OR 0.69, CI 95% 0.54 - 0.87).

Discussion and conclusions

As far as we know, this study is the first large-scale survey carried out on the prevalence of NSIs and their associated factors among nursing students in Italy. Four nursing schools from Northern Italy, 2 from Central Italy, 5 from Southern Italy and one from Albania (associated with the Nursing School of the “Tor Vergata” University in Rome) participated in the study.

The national educational system of the university nursing schools provides 1,800 hours of internship, distributed differently in the three years of the course, during which the nursing students, under supervision, provide direct assistance to patients. Trainees, especially in the 3rd year, carry out complex invasive operations with a high risk of exposure to biological materials. In our study, 11.8% of the students suffered at least one NSI ranging from 7.0% to 25.6%. Stefanati et al. (16), Cheung et al. (17) and Souza- Borges et al. (18) found percentages of NSIs among nursing students equal to, respectively, 18.8%, 6.9%, 18.1%. while higher percentages were highlighted by Yao et al. (19), Karadag (20), Ozer et al. (21), Zoungrana et al. (22), Yamazhan et al. (23)

and Prasuna et al. (24) in which the NSIs occurred, respectively, in 26.02%, 35.5%, 39.4%, 64.1%, 28.1%, 39.76% of nursing students. Our study did not investigate the geographical differences in NSI frequency, that will be considered in a larger study that will be carried out in collaboration with the SITI working group on Occupational Hygiene. Among the nursing students who suffered a NSI, 58.1% declared they had performed the PEP. Promptly communicating the accident would provide important data for appropriate treatment and for future accidents prevention; to this end, health organizations should implement a clear and shared complaint procedure in conjunction with an efficient accident reporting system. International data found that more than half of the injuries involving trainees are not reported to the appropriate Health Service (7, 13, 15). In our study, the students declared that in 24% of cases the NSI occurred during the disposal of sharp or pointed devices; among these, 14.5% did not perform the PEP. Stefanati et al. (16) and Cheung et al. (25) found lower rates of the NSI that occurred during the disposal of sharp or pointed devices (3.52% and 6.98%, respectively). Atypical reasons were reported by the students about the lack of adherence to the preventive procedures. The sentence: *"The doctor said there was no risk because the patient had to do a check for tuberculosis"* is demonstrative of the lack of education about evidence-based recommendations. The execution of blood samples represented the circumstance of the NSI in 13% of cases; in 32.5% of these the PEP was not performed, even when the needle was dirty. Also in this case, the explanations offered by the nursing students about the failure to adhere to the post-exposure protocols are worrying (*"I was not aware of the procedure"*, *"I was discouraged"*, *"I did not consider it necessary"*). Cheung et al. (17) found that the non-use of kidney dish to contain the needle or cutting edge used (OR, 4.2; CI 95%, 1.7-10.3) and the delay

in the disposal of potentially infected cutting edges in a rigid container (OR, 2.9%, CI 95%, 1.2-7.4) are risk factors for the NSIs. A common practice among nursing students was the re-capping of the needle, which in 15% of the cases represented the cause of the NSIs. It is worrying that the student justified the failure to adhere to the recommendations by saying: *"The nurse on duty said there was no danger."* From the literature it emerged that the re-capping maneuver is frequently performed by many HCWs (16-19, 22, 25). These results lead to a careful reflection. In fact, after 27 years from the issue of the Ministerial Decree of 28/09/1990, which in art. 2 states, *"The elimination of needles and other sharp objects, used for any kind of patient, must be done with caution suitable to avoid punctures or accidental cuts. In particular, needles, scalpel blades and other single-use sharp or cutting instruments must not be removed from the syringes or other supports or in any way handled or re-capped, but placed, for disposal, in appropriate containers resistant to puncture"* (26), the observation that HCWs still perform risky maneuvers requires the development of improvement strategies. To this end, health institutions should guarantee and encourage the acquisition of the necessary knowledge of clinical risk through the planning of compulsory updating programmes for operators and intensive training programmes for students. Numerous studies have found that prevention is the most effective strategy to reduce the risk of occupational exposure (27-32). In particular, the quality of educational systems, theoretical and practical training, guarantee the prevention of HAIs (33). Health organizations, in compliance with the law in force *"concerning safety and health in the workplace"* (34), and the Directive 2010/32/EU *"concerning prevention of needlestick injuries in the health sector"* (35), have undertaken health policy actions aimed at the management and control of biological risk: guidelines for the prevention

of infections, standard precautions, vaccinations, post-exposure prophylaxis and adoption of safety needle devices. The training institutes, as well as the healthcare organizations, must not only provide the tools for the adoption of healthcare associated infections prevention strategies but also guarantee the necessary training for their effective use. In this study, for example, there was a lack of specific training regarding the use of recent medical devices with a safety mechanism.

The national health authorities have implemented the Legislative Decree No.19 of 2014 (36) on health and safety at work, but gaps remain that need to be addressed by the widespread analysis of the phenomenon.

The most alarming figure highlighted by the analysis of the results refers to the time when accidents occur most frequently. The first injury occurred frequently during the first internship period (25.3%). In particular, the probability of occupational exposure among students decreases as their clinical capacity increases. This result is consistent with the research of Petrucci et al. (37), Ozer et al. (21), Souza-Borges et al. (18), Talas (38) but not with those of Cheung et al. (17) and Smith et al. (7) According to the literature, clinical experience represents a protective factor against the occurrence of accidents (13, 39).

In order to obtain an effective and durable antibody response and avoid the risk of contracting HBV after an injury at work, it is important to recommend anti-HBV vaccination at a young age, ideally during childhood in accordance with the national vaccination policy (40, 41). A total of 96% of the students declared they were vaccinated against HBV. This high percentage is largely linked to the mandatory nature of the anti-hepatitis B vaccination for all newborns starting in 1991 (42). The vaccine coverage against HBV derived from our study found similarities with the research of Karadag (20), Yamazhan et al. (23), Yao et al. (19) and Ozer et al. (21) who, respectively, found a

coverage ratio of 98.6%, 85%, 100%, 97.2%; lower results were obtained by Zoungrana et al. (22) and Yao et al. (39), showing percentages of 15.1% and 50%, respectively. Although the vaccination coverage shown by the survey sample was high, awareness campaigns on the phenomenon are essential, as among 74% of the students who had the antibody titre checked, only 82% recalled the outcome. The theoretical teaching of hygiene and occupational medicine provided by the educational system of nursing schools was the main source of information for students about occupational risk and PEP in case of NSI with a biologic fluid. In addition, the students stated that training in safety and risk control in the care setting took place in 49.8% of cases in all departments, in 41.2% only in some cases and none in 10%. Shiao et al. (13) underlined that lack of training by the host operating units represents a risk factor for the NSI. It is, therefore, essential to strengthen training in all areas. Strong scientific evidence revealed that the presence of professionals trained specifically in the prevention and control of HAIs significantly reduced their number in healthcare organizations (43). With a view to improvement, the professional prevention and control specialists could define and guarantee specific training interventions for nursing students, also using the methodology of field training. Lack of knowledge is the major reason for non-adherence to preventive strategies (33). An interesting result was obtained by Yao et al. (19) who, following a specific training programme for occupational exposure among nursing students, found a statistically significant difference ($p < 0.005$) in the frequency of cases, according to the behaviour and the knowledge in the prevention of NSIs.

In conclusion, our study found in agreement with the revised literature: lack of training (13), limited clinical experience (12, 13, 39, 44, 45, 46), insufficient skill (13, 38, 39, 44, 45, 46) and poor perception of the level

of risk (38, 44, 45) represent the main risk factors of occupational exposures among staff in training.

The elements of work safety are a basic chapter of training (43, 47, 48). The alignment of academic programmer with the skills required by the work environment is essential in achieving the curricular objectives. The development of the individual's empowerment represents the action strategy to be undertaken and shared at an inter-sectoral level to guarantee an improvement not only of the individual component, but also of an organizational and social one. The planning of training programmes should be preceded by the analysis of the reference context that guarantees the collection of information and useful data regarding the needs of the community of nursing students. The results of this study can be used as a basis of knowledge to establish targeted intervention strategies and to review and harmonize the educational programmes in order to minimize the occurrence of this event among nursing students.

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Riassunto

Studio multicentrico su epidemiologia e prevenzione delle ferite da punta negli studenti dei corsi di laurea in infermieristica

Introduzione. Tra le professioni sanitarie che prevedono un lungo periodo di tirocinio, gli studenti del Corso di Laurea in Infermieristica sono i più esposti al rischio biologico derivante da infortuni, in particolare con aghi e taglienti. Obiettivo dello studio è stato stimare la frequenza e le modalità di accadimento di infortuni con aghi, come base conoscitiva per mirati interventi di prevenzione.

Metodi. Lo studio è stato condotto nel periodo maggio - luglio 2017 in 11 Università italiane e 1 albanese attraverso la somministrazione di un questionario anonimo

agli studenti del 1° (secondo semestre), 2° e 3° anno del Corso di Laurea in Infermieristica.

Risultati. Sono stati raccolti 2742 questionari. Il 73% dei rispondenti era di sesso femminile, l'età mediana 22 (da 19 a 60 anni). Trecentosedici studenti (11,8%) hanno dichiarato di aver subito almeno 1 infortunio (12,7% tra le femmine e 9,7% tra i maschi), 41 studenti ne hanno dichiarati 2 o più e 4 non hanno dichiarato quanti. Il primo infortunio si è verificato in media dopo 17 giorni (mediana 15 giorni) dall'inizio del tirocinio; la percentuale più elevata di infortuni si è verificata durante il primo tirocinio (25,3% del totale) ed è andata diminuendo col progredire del percorso formativo. Nel 38% dei casi l'infortunio si è verificato durante la preparazione del farmaco, nel 24% durante lo smaltimento dell'ago, nel 15% durante il re-incappucciamento dell'ago, nel 13% durante l'esecuzione del prelievo e nel 10% in altre circostanze. Nel 51,2% degli infortuni l'ago era "sporco". La profilassi post esposizione è stata effettuata nel 58,1% dei casi. Il 96% degli studenti era vaccinato contro l'epatite B, ma, tra gli studenti che hanno dichiarato di essere stati sottoposti alla verifica del titolo anticorpale (74%), il 18,3% ha dichiarato che tale titolo non era risultato protettivo. Il 49,8% ha dichiarato di essere stato addestrato sulle corrette procedure per la prevenzione delle ferite con taglienti e aghi in ogni reparto frequentato, il 41,2% solo in alcuni reparti e il 10% in nessun reparto.

Conclusioni. I risultati dello studio evidenziano una percentuale elevata di infortuni negli studenti del corso di Laurea in Infermieristica. Emerge, pertanto, la necessità di un'attenta riflessione sulle modalità più efficaci di formazione finalizzata all'acquisizione di conoscenze, abilità e modelli comportamentali utili all'esercizio della professione.

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